Unit 3 - Week 2

Assessment 3

The due date for submitting this assignment has passed. Due on 2016-03-18, 23:59 IST.

Submitted assignment

Assume speed of light to be 3 x 10^8 m.s^{-1}; Planck's constant h = 6.626 x 10^{-34} J.s. All references to particle in a box mean that problem of one dimensional box with infinite potential at boundaries and no potential inside, unless mentioned otherwise.

1) The function $\psi(x) = \sqrt{\frac{2}{L}}\{\sin\frac{4\pi x}{L}\}$, is an eigenfunction for the free particle in a box (with zero potentials inside) Hamiltonian and has the eigenvalue *1 point*

- $\frac{h^2}{8mL^2}$
- $\frac{2h^2}{8mL^2}$
- $\frac{4h^2}{8mL^2}$
- $\frac{16h^2}{8mL^2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{16h^2}{8mL^2}$

2) The function, $\psi(x) = e^{\frac{i4\pi x}{L}} - e^{-\frac{i4\pi x}{L}}$ satisfies the differential equation *1 point*

- $\frac{d\psi}{dx} - \frac{4i\pi}{L}\psi = 0$
- $\frac{d\psi}{dx} + \frac{4i\pi}{L}\psi = 0$
- $\frac{d\psi}{dx} + \frac{16\pi^2}{L^2}\psi = 0$
- $\frac{d\psi}{dx} - \frac{16\pi^2}{L^2}\psi = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\frac{d\psi}{dx} + \frac{16\pi^2}{L^2}\psi = 0$

3) Two particles with masses m_1 and 9 m_1 are in two one dimensional boxes of length 3L and L respectively. For any same quantum number for both particles, their energies are in the ratio *1 point*

- 1:1
- 64:1
- 16:1
- 1:64

No, the answer is incorrect.
Score: 0

Accepted Answers:
1:1

4) The probability of finding the particle in an eigenstate with quantum number n=5, in a box of length L, in the region x=L/5 to x=2L/5 is *1 point*

- 1/10
- 1/5
- 2/5
- 1

No, the answer is incorrect.
Score: 0

Accepted Answers:
1/5

5) An electron (mass 9.31×10^{-31} kg) is trapped inside a one dimensional box of length 1 micrometer. The energy required to push the electron from the lowest quantum state (n=1) to a state with n=5 is *1 point*

- $1.41 \times 10^{-27} J$
- $1.41 \times 10^{-24} J$
- $1.41 \times 10^{-22} J$
- $1.41 \times 10^{-21} J$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$1.41 \times 10^{-24} J$

6) The energy of the particle in a one dimensional box and the energy difference between two nearby energies (with quantum numbers n and n+1) are respectively proportional to *1 point*

- n^2 and n
- n^2 and n^2
- n and n
- n and n^2

No, the answer is incorrect.
Score: 0

Accepted Answers:
n^2 and n

7) For the wave function of a particle in a box given by cx(L-x) where c is the normalization constant, the probability of finding the particle between x=0 and x=L/2 is **1 point**

- 1/6
- 1/30
- 1/2
- 1/3

No, the answer is incorrect.
Score: 0

Accepted Answers:
1/2

8) The energy of a particle in a box under a constant potential V inside the box is quantized and given by **1 point**

- $E = \frac{h^2 n^2}{8mL^2} - V$
- $E = \frac{h^2 n^2}{8mL^2} + V$
- $E = (\frac{h^2}{8mL^2} - V)n^2$
- $E = (\frac{h^2}{8mL^2} + V)n^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$E = \frac{h^2 n^2}{8mL^2} + V$

9) An integral involving two eigenfunctions $\psi_1(x) = \sqrt{\frac{2}{L}} \sin \frac{2\pi x}{L}$ and $\psi_2(x) = \sqrt{\frac{2}{L}} \sin \frac{4\pi x}{L}$ of a particle in a box of length L is given as an overlap integral and is equal to $\frac{2}{L} \int_0^L \sin \frac{2\pi x}{L} \sin \frac{4\pi x}{L} dx$ Its value is **1 point**

- 1
- 2/L
- L/2
- 0

No, the answer is incorrect.
Score: 0

Accepted Answers:
0

10) The mass of a nitrogen molecule is approximately 4.65 x 10^{-26} kg. Assume it is in a one dimensional box of length 1m. Its energy is given by $7k_BT/2$ where k_B is the Boltzmann constant, 1.38 x 10^{-23} J.K^{-1} and T is 1500 K. The quantum number corresponding to this state of nitrogen molecule is closest to **1 point**

- 2.5 x 10^{15}
- 2.5 x 10^{11}
- 2.5 x 10^{9}
- 2500

No, the answer is incorrect.
Score: 0

Accepted Answers:
2.5 x 10^{11}

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